CLINICAL RESEARCH STUDIES

From the Western Vascular Surgery

Subclinical embolization after carotid artery stenting: New lesions on diffusion-weighted magnetic resonance imaging occur postprocedure

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Objectives: **The reported rate of subclinical brain injury after carotid artery stenting (CAS) seen on diffusion-weighted magnetic resonance imaging (DWI) varies from 10% to >40%. Data from transcranial Doppler after CAS indicate that embolization may continue for several days, suggesting that that at least some lesions seen on DWI occur postprocedure. Because DWI lesions appear ≤1 hour of embolization, we used DWI to prospectively study patients before CAS, 1 hour after, and 48 hours after CAS to answer this question.**

Methods: **The study participants were 48 male patients aged 59 to 83. All patients were examined by a neurologist before and after the procedure and had DWI preprocedure and 48 hours postprocedure. In addition, 23 patients had a DWI 1 hour post-CAS. Magnetic resonance imaging exams, including axial and coronal DWI and fluid-attenuated inversion recovery images, were read by two neuroradiologists blinded to the study timing. The embolic protection device was obtained from all patients, washed, and the contents examined under a digital microscope for fragments ≥60 μm.**

Results: **There were two periprocedural strokes and one transient ischemic attack (TIA), but no strokes or TIAs occurred during follow-up. In the 23 patients imaged 1 hour postprocedure, new lesions were found in two (9%), and 18 (78%) had new lesions at 48 hours ($P < .001$). For the entire study group, the incidence of new lesions at 48 hours was 67% (36/54). The median number of DWI lesions was four (range, 1 to 17). Every protection device examined had atherosclerotic debris, with a mean of 135 ± 73 fragments (range, 18 to 310) sized >60 μm and a mean of eight fragments (range, 2 to 21) sized >500 μm. Findings on postprocedure DWI did not correlate with the degree of stenosis, size of angioplasty balloon, or number of inflations, nor with the number or size of fragments retrieved from the protection device.**

Conclusions: **CAS can be performed with a very low incidence of clinically evident neurologic events; however, it is associated with embolization during and after the procedure. Protection devices effectively prevent clinical and subclinical events during the procedure. Significant embolization continues for at least 48 hours postprocedure, causing lesions on DWI when there is no mechanism for cerebral protection. These data correlate with transcranial Doppler reports of continued embolization after CAS and indicate that DWI should be done as late as possible to accurately assess the rate of subclinical brain injury with CAS procedures. (J Vasc Surg 2007;45:867-74.)**

Ex vivo experiments[1,2] and in vivo transcranial Doppler (TCD) monitoring[3] have shown that carotid angioplasty can release large numbers of plaque fragments into the cerebral circulation. Thousands of plaque fragments were retrieved downstream after ex vivo angioplasty, whether or not the lesion was stented.[4] To protect the brain from this embolic barrage, carotid angioplasty is now routinely performed with a sieving, or embolic protection device, placed in the distal artery. There is concern about the degree of protection afforded by these devices, however.[5] Plaque material may be dislodged as the device is maneuvered through the stenotic lesion before deployment. The devices have a pore size of approximately 100 μm, a particular concern because our ex vivo data suggest that most particulates released with angioplasty have a maximum diameter <100 μm.[1]

TCD monitoring of patients undergoing carotid angioplasty has confirmed that particulates enter the cerebral circulation even when protection devices are in place.[6]

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Competition of interest: none.

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Although in most cases the number of particulates detected did not correlate with new neurologic symptoms, tens to several hundred solid emboli were detected.[3,6]

Because of our concern about these cerebral emboli, a protocol was established as a collaboration between the Vascular Surgery, Radiology, and Neurology Services when the carotid stenting program was initiated at our facility, the San Francisco VA Medical Center, to examine the causes and consequences of these cerebral emboli with the goal of reducing their number to a minimum. This required a prospectively accumulated database, which included documenting the incidence of both clinically evident and subclinical brain injury using diffusion-weighted magnetic resonance imaging (DWI, MRI).

Previous reports using DWI to examine subclinical brain injury after carotid stenting have looked at only one study postprocedure. When studies have been done ≤24 hours, new lesions were observed in 17% to 53% of cases.[3,7-9] Reports of DWI done at 48 hours show a trend toward a higher incidence,[10,11] possibly because of the continued embolization seen on TCD monitoring.[12] To ensure that we included the full extent of subclinical injury post-CAS, we initiated our series by imaging patients as late as practical, at 48 hours. When we also observed a significant number of new lesions on DWI at this time point, we realized that to determine what might be done to reduce the incidence, the first step was to clarify whether the lesions were the result of intraprocedural or postprocedural embolization. Therefore, a third study at 1 to 2 hours postprocedure was added to the protocol.

METHODS

The study was done as a prospective, nonrandomized examination of carotid angioplasty and stenting (CAS) conducted from February 2005 through August 2006. Patient selection was done as follows. A discussion was undertaken with each patient by a member of the research team or the referring practitioner about the relative risks and benefits of CAS vs endarterectomy, which included a review of the aortic arch and proximal carotid anatomy to assess the feasibility of CAS. Thereafter, patients who chose to undergo CAS were approached to participate in the study. The study population consisted of 48 male patients with a mean age of 71 years (range, 59 to 83 years). They underwent 54 procedures for asymptomatic critical stenoses (n = 25) or symptoms of transient ischemic attack (TIA; hemispheric in 15, amaurosis fugax in 5) or cerebrovascular accident (n = 9). During the same period, nine patients undergoing CAS either declined to participate or could not undergo MR scanning, and 38 patients underwent carotid endarterectomy. The protocol and consent form were approved by the Committees on Human Research at University of California, San Francisco, and San Francisco Veterans Affairs Medical Center.

There were two phases of the protocol for identifying new lesions on DWI. In the first 31 cases, we obtained DWI at 48 hours only. The procedure was then changed to include DWI at 1 to 2 hours postprocedure and at 48 hours in 23 cases. All 54 cases undergoing CAS and DWI are reported.

To ensure that the lesions seen on the postprocedure DWI were new, each subject had a study ≤72 hours before the procedure and postprocedure studies at 1 hour and 48 hours, as noted above (Figure 1). The DWI included axial and coronal DWI and fluid-attenuated inversion recovery (FLAIR) images (DWI: echoplanar spin-echo, TR/TE = 5000/100 milliseconds, b = 0.500, 1,000, 20 5-mm thick slices with a 1.5-mm gap, matrix size-128 × 128; FLAIR: TR/TE/TI = 8000/120/2000 milliseconds). Average diffusion coefficients maps were calculated from the DWI images.

The MRI studies were independently read by two neuroradiologists (M. W. and C. G.) who were blinded to study timing. An acute ischemic lesion was diagnosed when it was seen on either axial or coronal DWI images and confirmed on the corresponding average diffusion coefficients maps, or was seen on both planes of DWI. To be considered indicative of acute injury, the lesion could not appear on preprocedure imaging and no corresponding FLAIR abnormality could be present for the lesion to be considered as acute. New (acute) lesion location and size were recorded. In cases of initial disagreement between readers, consensus was reached by joint review of the cases.

Every patient was examined by a neurologist, both before and after the procedure, using the National Institutes of Health Stroke Scale.

The carotid stenting procedure was performed as follows. In addition to the DWI, a preprocedure magnetic resonance angiography was done that included a three-dimensional display of the aortic arch; therefore, arch angiography was avoided in most cases (81%). After achieving access to the proximal thoracic aorta, a telescoping technique using the Shuttle Select Sheath (Cook, Bloomington, Ind) and the JB1 (right carotid; Cook) or V-Tek (left carotid; Cook) catheters was used to cannulate the appropriate great vessel.

Angiography to confirm the extracranial and intracranial anatomy was performed, and the embolic protection device was placed into the distal internal carotid artery. The AccuNet device (Guidant, Mountain View, Calif) was used in 51, and the Angioguard (Abbott, Abbott Park, Ill) was used in three. Predilation angioplasty, stent deployment (AccuLink, Guidant; or Xact, Abbott), and postdilation angioplasty were performed (Figure 2).

After angiography to confirm satisfactory treatment of the stenosis, the protection device was removed and completion angiograms were obtained. Periprocedural anticoagulation consisted of pretreatment with clopidogrel in all patients, which was continued postprocedure for 6 weeks; intraprocedural heparin given to achieve an activated clotting time of >300 seconds and then continued for 12 hours postprocedure.

An embolic protection device was used in all cases. This was retrieved for fragment analysis in 44 cases. The collapsed filter basket was rinsed with saline to remove adher-

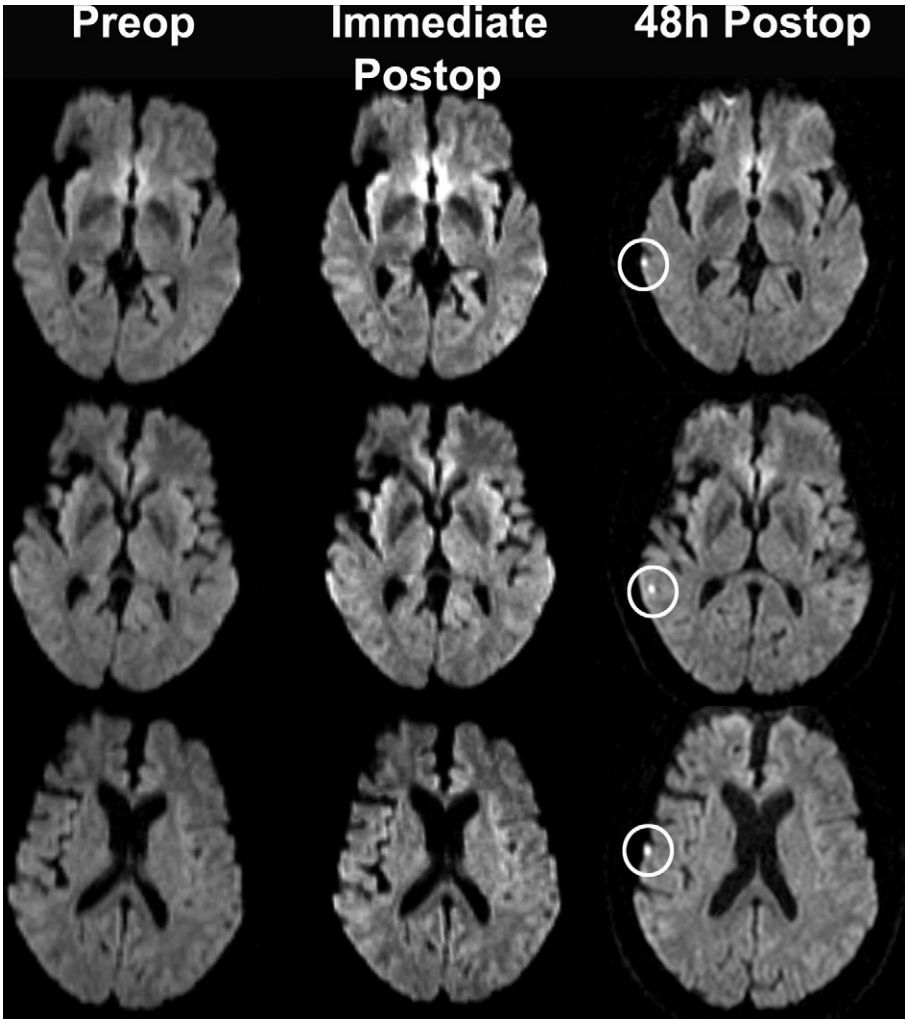

Fig 1. Diffusion-weighted images before, 1 hour, and 48 hours after carotid stenting show three small, new lesions in the right hemisphere.

ent blood. After re-expansion, the contents were obtained by washing with approximately 20 mL of saline, which was then centrifuged, the supernatant decanted, and the fragments examined at ×120 under a Zeiss Digital Microscope (Carl Zeiss, Oberkochen, Germany). Photos were taken and fragments measured and counted. With each specimen, a sham control was also done to monitor the debris that may have been included in the saline and glassware. This was subtracted from the fragment count.

RESULTS

One TIA occurred and two periprocedural strokes (stroke rate, 3.7%). One stroke occurred 6 hours after a left internal carotid artery CAS and affected the fine motor function of the patient's right hand. The second occurred after plaque fragments released during postdilation of the stent occluded the embolic protection device, requiring passage of a second wire and catheter to aspirate the atherosclerotic debris and restore flow. The symptoms were confusion and a mild facial droop and were associated with an area of brain infarction on MRI, the only infarct on MRI in the series. In both patients symptoms had completely resolved by their 2-week follow-up visit. There were two myocardial infarctions, but no deaths. One femoral artery pseudoaneurysm required thrombin injection, and two groin hematomas requiring evacuation occurred early in the series.

Four patients had areas of acute injury on DWI before their carotid artery stent procedure. In the 23 cases where DWI studies were performed 1 to 2 hours postprocedure, only two (9%) had new lesions immediately postprocedure, and 18 (78%) had new lesions when imaged at 48 hours ($P < .001$; Table I). In the entire group there were new lesions at 48 hours after 36 (67%) of the 54 procedures. The median number of new lesions on DWI was four (range, 1 to 17). Most measured 1 to 2 mm in diameter, with the largest lesion measuring 7 mm. There were new lesions ipsilateral to the procedure in 97% of cases. In 28%, lesions

Fig 2. A, Preprocedural and **B,** postprocedural views of a critical internal carotid lesion. Note the continued presence of a small area of luminal irregularity extending outside the stent.

were seen in the contralateral hemisphere as well. In one case, there were two lesions in the contralateral hemisphere and none ipsilateral to the CAS procedure.

When viewed with the digital microscope and the appropriate sham subtractions were done, every protection device examined had atherosclerotic fragments, with a mean of 135 ± 73 (range, 18 to 310) fragments sized >60 μm, and a mean of eight fragments (range 2 to 21) sized >500 μm (Table II) (Figure 3). We examined the relationship of the number and size of the fragments retrieved from the embolic protection device with the degree of plaque stenosis, conduct of the procedure, and findings on post-procedure DWI. There was no correlation of the number or size of fragments retrieved from the embolic protection device and degree of stenosis, size of angioplasty balloon, number of inflations, or number of new lesions on DWI.

Table I. New lesions on diffusion-weighted imaging

Group	*Patients (n)*	*Positive at 1 h*	*Positive at 48 h*
Imagined at	54	—	36 (67%)
48 h	54	—	36 (67%)
1 h and 48 h	23	2 (9%)*	18 (78%)*

*$P < .001$.

Table II. Number of fragments >60 μm captured in the embolic protection device

Size (μm)	*Mean*	*SD*
60-99	84.4	45.7
100-199	24.2	31.0
200-499	11.1	11.0
500-999	3.9	4.5
>1000	1.6	2.8
Total	135.2	73.5

DISCUSSION

Our data indicate that as carotid stenting is currently practiced at our institution, nearly all embolic brain injury occurs postprocedure. Although some late ischemic events were expected to occur, we can only speculate why, during a time period when thousands of plaque fragments are released,[1,3] injury to the brain is rare, while later, when the embolic rate is considerably lower, brain injury is virtually the norm.

Our first thought was that the embolic protection device was highly effective. Although the pore size of the AccuNet that was used for most our cases is 120 μm, it should entrap larger fragments that are likely to cause ischemia.[4] Furthermore, it is more effective than one might predict in trapping fragments sized <100 μm.

Second, the published TCD data gleaned from only 20 or 30 minutes of monitoring may underestimate both the incidence and frequency of emboli postprocedure. A more thorough examination of embolic burden after carotid stenting will require longer periods of TCD monitoring.

Third, there could be late thrombus formation on the stent or propagation of clot from a nonoccluding embolus in the microvasculature. Heparin was discontinued 12 hours after the procedure, although daily clopidogrel was prescribed for 6 weeks. We have found in an animal model of embolic stroke that even high concentrations of heparin have no impact on the incidence or number of brain lesions from microemboli (unpublished observations), making this explanation unlikely.

Finally, it is also unlikely that there may have been areas of injury that were not imaged by the 1-hour postprocedure DWI study. DWI has been shown to be positive within

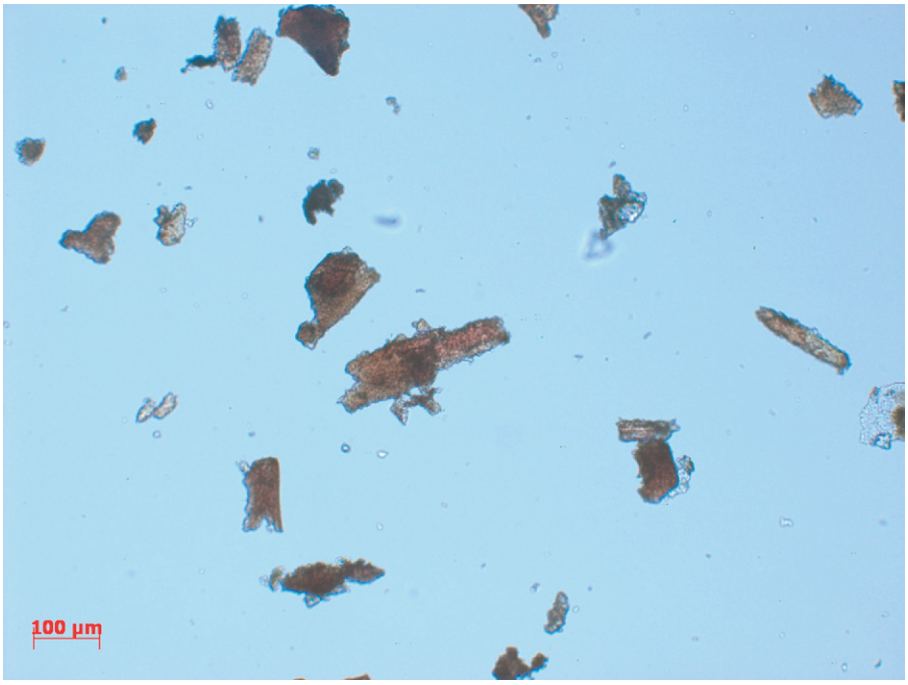

Fig 3. Debris recovered from an embolic protection device. The range of sizes includes atherosclerotic tissue fragments above and below 100 µm in size.

minutes of injury in both animals and humans,[13,14] and no scan was done less than 1 hour after stent deployment and postdilation angioplasty.

New lesions were seen on DWI after two of every three CAS procedures in this series, which is nearly double the rates reported after 24 hours.[7,9,15] It is also somewhat higher than other reports of DWI done 48 hours postprocedure.[10,11] Some of the difference may be technical. Most studies report only single-plane imaging, but our DWI was done in both the coronal and axial planes. If only the coronal sections were read, the number of lesions was reduced by one third, placing our data in the mid-range of the other reported incidences. Clearly, the more complete evaluation of brain injury performed at least 48 hours postprocedure is to be preferred if one is examining the incidence of new lesions on DWI.

CAS is being introduced as an alternative to carotid endarterectomy, which rarely is accompanied by new lesions on DWI. We[16] and others[17] have shown that new lesions are rarely seen on DWI after carotid endarterectomy, and in a comparison of CAS and endarterectomy, Roh et al[18] found that both neurologic events and new lesions on DWI were far more common with CAS.

In contrast to the incidence of subclinical injury, the clinical outcomes in this series are comparable with carotid endarterectomy, raising the question of the importance of these lesions seen only on DWI. It would be naive to reflexly respond that all brain injury is to be avoided. In the short term, these lesions seem to have no measurable consequences, and by 6 months post-CAS, most have resolved without residual effects.[9]

Repetitive embolic injury may have a cumulative effect, however. Recently, a link has been established between the numbers of emboli found during TCD monitoring in patients with vascular dementia and Alzheimer disease compared with nonaffected controls.[19] Although much work needs to be done to understand the mechanism of repetitive emboli and dementia, it is premature to consider these subclinical events unimportant, and until an approach is developed that will reduce their incidence, they remain a cause of concern.

We used a digital microscopy with ×120 power to examine the material washed from the embolic protection devices. With this level of scrutiny, all devices contained plaque fragments, and many had maximal diameters smaller than the device pore size. This, combined with the lack of injury while the device is in place, seems to leave little debate as to its utility. Even with our aggressive examination of the embolic protection devices, we could not correlate fragment number or size with clinical events, or with new lesions on DWI. Given that the emboli causing new lesions occurred after the procedure, this lack of correlation should be expected.

CONCLUSION

We are reporting a series of 48 patients undergoing 54 CAS procedures with excellent clinical outcomes but a concerning number of new lesions on DWI. These subclinical brain injuries did not occur during the procedure but in the ensuing 48 hours, when transcranial Doppler studies have confirmed an ongoing number of embolic events. We submit that the CAS procedure itself is safe, but new

approaches should be considered to prevent microembolization postprocedure.

AUTHOR CONTRIBUTIONS

Conception and design: JHR, RS, MY, MW
Analysis and interpretation: JHR, LW, XMP, CG, SC, MW
Data collection: SW, XMP, RS, MY, CR, SC, MW
Writing the article: JHR, MW
Critical revision of the article: JHR, XMP, MW
Final approval of the article: JHR, RS, LW, XMP, MY, MW
Statistical analysis: LW
Obtained funding: JHR
Overall responsibility: JHR

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DISCUSSION

Dr Ralph Dilley (LaJolla, Calif). President Andros, members and guests. The growing interest of using stents to treat carotid atherosclerosis is now well documented, and the modality is being used increasingly in many clinics and practices, often in patients who are asymptomatic and not in high-risk categories.

Unfortunately, we are beginning to learn of a number of potentially significant complications of carotid stenting, which might limit the application of this intervention. For instance, a number of recent reports have shown an increase in postprocedure stroke risk in patients over age 80. The incidence in these reports varies from 7% to 15%.

Second, almost all investigators agree it is important to use protection devices to decrease the frequency of atheroemboli during carotid stenting. These protection devices range from simple filters to the more complex flow reversal system as described by Parodi, but skepticism remains about their efficacy in capturing atherosclerotic particles.

In spite of these precautions, atheroemboli continue to occur during carotid angioplasty and stenting, and now we learn from this very nice presentation by Dr Rapp and his colleagues that atheroembolic showers occur not only during the procedure but continue at least up to 48 hours following the procedure when no protection device is in place.

Using diffusion-weighted MRI, analyzed both in coronal and axial planes, they demonstrated a 9% incidence of new lesions at 1 to 2 hours after the stent placement but also a highly significant 78% incidence at 48 hours. Most patients had multiple lesions, most often in the treated carotid distribution. All patients in their study had placement of a protection device during the intervention, and plaque fragments were present in the 44 submitted for analysis.

This is an excellent study and if you are concerned that these microembolic showers, although asymptomatic at the time, may ultimately cause problems, then the results of this study are indeed sobering and prompt many questions about the role of carotid stenting. I should hope the authors would comment on some of these questions.

Were you able to correlate the incidence of new lesions with the age of the patient? Is it likely that the embolic lesions, particularly those outside the carotid territory were related to arch atherosclerosis with embolic debris caused by catheter manipulation?

I noted that the evaluation of the arch was by MRI only in about 80% of the cases, and I wonder if this technique is sensitive enough to identify significant arch pathology, which if present, might alter the treatment plan?

Were you able to correlate the number of embolic lesions with any preintervention characteristics of the carotid plaque? For instance, how did patients with recurrent disease as an indication compare with de novo disease, and did you attempt to characterize the plaque by duplex as to its degree of instability or heterogeneity versus a stable or homogeneous plaque?

Should the workup prior to carotid stenting include transesophageal echo to exclude arch pathology or duplex to evaluate plaque characteristics, the findings of which might rule out stenting as an option?

Can you elaborate a little further on what the clinical significance of these lesions is? If they are a precursor to a dementia syndrome and continue to embolize up to 48 hours or more, they are very significant and a deterrent to expanding the indications for carotid stenting.

Finally, a number of your patients in the study were asymptomatic, and can you justify treating asymptomatic patients with a stent, particularly with the findings you report today?

Again, I enjoyed this presentation and congratulate the authors on an excellent study.

Dr Joseph Rapp. Thank you, Ralph. Ralph was very kind to not comment on the extremely rough draft that I sent him the first time around.

So do we know the timing of these lesions and could it happen that we are just missing it and they are embolizing at the end of the procedure and not during the procedure? Transcranial Doppler during the procedure I think is pretty well worked out, and I do not really understand why we do not have good data postprocedure because these people are monitored during the procedure in some of these studies. We do not do transcranial Doppler. Actually we now have a machine and we are going to start doing it for obvious reasons that I talked about. And so I don't know actually the timing. My actual suspicion is that there is a lot more emboli in the postprocedure period than we appreciate, and I think we are going to look at that and hopefully work that out.

Does it correlate with age or the heterogeneity/homogeneity of the plaque? Well, I hate to admit to a group of vascular surgeons but I do not believe in homogeneity or heterogeneity of the plaque, so we do not get it. I never have been convinced that was worthwhile, but I know many of you do not share that opinion and so you are welcome to do that study and see. We looked at every parameter other than that that we could think of—degree of stenosis, length of the lesion. You know we have MRI. We look at all these lesions, and we could find nothing that correlated. We only had 3 or 4 recurrent lesions, so it really was not worth looking at whether they were recurrent or not. The recurrent lesions do actually shed particles, which I was interested to find out . . .

Unidentified speaker. . . . paper was appreciated very much. It was beautifully presented with good data, as usual. I have two questions and a couple of comments. You mentioned that we "don't get emboli with carotid endarterectomy." In fact, have you subjected a group of patients in your institution who have undergone carotid endarterectomy to the same rigorous examination with DWI as you did those undergoing angioplasty? Certainly if you do transcranial Doppler on people that undergo CEA you see a lot of hits in those patients, you just do not see them for long periods of time, and while this may have been studied, I am not aware of any literature right now to show that there are lesions DWI after CEA unless there is an obvious complication. I am just wondering if you happened to look at it because I think you are in an excellent position to do that and to compare it.

Dr Rapp. We have. We published that in the *Journal of Neuroradiology* in I think 2000-2001, and there is one from the neurosurgery group in Phoenix. We found one lesion in 25 and they found no lesions in 27 in diffusion-weighted imaging, so they are emboli. I misspoke. I said there were no emboli. There are no diffusion-weighted lesions after endarterectomy.

Unidentified speaker. The second question has to do with your anticoagulant and antiplatelet regimen periprocedure. Would you tell us a little bit about how much heparin you use, whether you use aspirin and Plavix, and when you start it and how long you continue it?

Dr. Rapp. We keep the ACT greater than 300 during the procedure and we continue heparin for 12 hours postop, and in the paper, one of the other alternatives that I mention is that maybe when you stop the heparin you are getting more emboli. We load the patients with Plavix either by 3 days before or, rarely, we load them the night before, depending on their proximity to us, etc. We continue Plavix for 6 weeks. Dr Pann and I have looked at antiplatelet agent anticoagulation in our rat model of emboli, and I can tell you even big doses of heparin make not a wit of difference in the incidence or the number of lesions that you get when you embolize cholesterol crystals.

Unidentified speaker. That is exactly the point. It suggested it is not platelet or thrombotic material that is embolizing; it is really plaque embolization that is really critical.

Obviously papers like this, for those who are interested in carotid endarterectomy, make our day, or at least seem to, and you are presenting this to a group of people who are very receptive obviously to the data that you are presenting. I would strongly encourage you to present this again at the stroke meetings, the American Heart Association, where you do have an eclectic audience of neurologists, neurosurgeons, vascular surgeons, etc, because they are the ones who need to hear this. There is a proposal up right now as a tag onto the CREST trial to do neuropsychiatric evaluations of patients in both the carotid endarterectomy as well as in the stenting group to see whether or not there is a difference in intellectual functioning and whether or not these DWI lesions in fact will be forerunners of dementia. I think it is terribly important. Whether it gets funded or not is another question. I enjoyed the paper and congratulations.

Dr Rapp. Thank you, and, Wes, I am only trying to continue the work that you started at the San Francisco VA.

Dr James Watson (Seattle, Wash). I, like you, do not believe in intervening in carotid stenosis that is less than 80% unless they are clearly symptomatic, so I would like to drill down a little more on your definition of asymptomatic.

Before coming down here I was presented with about a 60% carotid stenosis who had an asymptomatic Hollenhorst plaque discovered on retinal examination. How would you manage that patient? And as a follow-up question, what do you do with the asymptomatic carotid stenosis with a shown stroke by CT that shows up in your office and says they have no symptoms, but once again has a 50% to 79% carotid stenosis? Do you treat those patients as symptomatic or asymptomatic?

Dr Rapp. I think they are tough calls. Generally, we treat them as asymptomatic. We treat them that we do not know when the stroke occurred. We do not know when the Hollenhorst plaque occurred, and they weathered the storm and they have done well. As you know, if you have your clinical event, you are at your highest risk of recurrent event at that time, and that risk actually goes down and at 2 years joins the population with carotid stenosis that has never had an event. I think if you do not know when the event started, you are down here in this low-risk category and you have a 60% stenosis and you are not going to do anything.

Unlike our colleagues, I just went to a (Fox-Hollow) event and was told that we should be treating asymptomatic SFA stenoses, so I think there is a group of people out there who are truly scary in their indications to do these things. As our cardiologists have discovered that there is atherosclerosis outside the heart, this is a problem. It is a real problem when you have one standard to do interventions and the person down the hall has another.

Dr Jean-Pierre Becquemin (Paris, France). I really enjoyed your paper because I think it brings new clues that these may not be so innocuous that we all hoped for. I was interested to see that the majority of events occurred later on, after deployment of the stent. That means that you change stable plaque to unstable plaque. That means that all the debris goes through the strut of the stents, and my question is did you use different types of stent? Did you find a difference between open-cell stents versus closed-cell stents?

Maybe you saw this paper at the last June meeting in Philadelphia from a Belgium group which showed that with a closed-cell stent, there were less emboli than with an open stent. Do you have the same experience?

Dr Rapp. I have no experience with that. What I am interested in actually is a covered stent and there is a study looking at covered stents in the carotid. Now that study was stopped because of their high rate of restenosis. I have the reference in my poring through Pub-Med to do this paper. I think that is very interesting, but I have no data on closed or open-cell stents.

Unidentified speaker. I enjoyed your paper very much. A couple of questions. There is some evidence experimentally at least that you can increase the number and size of emboli by using Dextran. Have you considered that?

Dr. Rapp. Increase?

Unidentified speaker. Decrease, size and number, by giving Dextran. The other question is, in light of all this then, should we be treating these people for 3 or 4 months with high-dose statins and antiplatelet therapy before we stent them?

Dr. Rapp. Two really great questions. I love Dextran. Using it for years and then in the last few, I don't know, maybe 3 or 4 years collectively had two anaphylactic reactions to Dextran, my love of Dextran has been tempered, but Dextran is a very good drug, and there is a wonderful TCD paper showing that these postoperative embolizations actually stop when they put on Dextran. I think Dextran is exactly where we are going to go. I am concerned about the anaphylactic reaction to it.

In terms of statins and pretreatment with statins, that is a great idea. Certainly in our asymptomatic patients where it is unclear there is a rush to treatment that may well be a wonderful thing to try.